SECTION 13XXX
CONTROL DESCRIPTION
(DICP Models 02-412NC, 412, 622, 826, 1030)

PART 1 - GENERAL

1.01 SUMMARY

This section describes the operation and control of a drip irrigation system. The major components of the integrated system include:

A. A wetwell which contains the liquid to be pumped to the irrigation fields,
B. Multiple floats to detect various liquid levels in the wetwell,
C. One or two pumps to move the liquid to the irrigation fields,
D. Two to ten filters to remove suspended particles prior to the liquids being fed into the drip irrigation lines,
E. A series of drip irrigation lines,
F. Zone valves to allow or block flow to as many as thirty sections of drip irrigation lines,
G. Two control valves to facilitate automatic filter backwash and zone flush,
H. A backwash valve for each filter,
I. An air compressor and pressure tank to aid in backwashing the filters,
J. A pressure switch to detect when filters need to be backwashed,
K. A digital flow meter for detecting flow and pacing the dosing of zones,
L. A telephone Autodialer for calling out alarm condition,
M. A control panel which includes:
    - A Programmable Logic Controller (PLC) to operate the integrated system,
    - An Operator Interface Console (OIC) for on-site control of the PLC,
    - An Uninterruptible Power Supply (UPS) for surge and lightning protection,
    - Isolation relays on outputs and inputs for lightning protection
    - Hand-Off-Auto (HOA) switches for on-site, manual control of inputs and outputs,
    - Communications devices to enable remote control of the PLC.

1.02 SYSTEM OPERATION

The integrated drip irrigation system receives a liquid from waste treatment facilities. The liquid is temporarily stored in a wetwell until there is sufficient volume to initiate zone dosing. Each zone receives a specified volume of liquid and then is allowed a period of "rest" time before it is "dosed" again. Filters remove suspended particles from the liquid stream to prevent the particles from being carried into the drip irrigation lines. The filters capture suspended particles and from time to time must be backwashed to remove the build up of any particles. On a less frequent basis, the drip irrigation lines must also be flushed with higher flows to remove any deposits of particles in the lines.

1.03 SYSTEM CONFIGURATION

The integrated drip irrigation system shall have various configurations, which allow for proper operation:

A. A small irrigation pump and large irrigation pump operating philosophy shall be incorporated into the PLC. The PLC's pump operating philosophy shall be easily toggled

between the two options through the OIC. The philosophy of each option shall be as follows:

- Only one zone shall be dosed at a time by an irrigation pump with output designed to match the drip irrigation output of the typical zone. Both irrigation pumps shall run when a zone is being "field flushed". This scheme of operation shall be known as the "small pump operating philosophy".
- Two zones shall be dosed at a time by an irrigation pump with output designed to match the drip irrigation output of two typical zones. Only one pump shall run when a zone is being "field flushed". This scheme of operation shall be known as the "large pump operating philosophy".

B. The zone dosing period shall be controlled by either a specified length of time or by a specified volume of liquid. This "zone-dosing mode of operation" shall be incorporated into the PLC. The PLC's "zone-dosing mode of operation" shall be easily toggled between the two options through the OIC.

C. The PLC and OIC shall be automatically configured to operate and display from four to thirty zones. Excess zones will be skipped in the PLC control logic and will be removed from the OIC screen. The configuration of the number of zones shall be through the OIC.

D. The PLC and OIC shall be automatically configured to operate and display from one to ten filters. Excess filters will be skipped in the PLC control logic and will be removed from the OIC screen. The configuration of the number of filters shall be through the OIC.

1.04 SYSTEM SETPOINTS

The integrated drip irrigation system shall have various setpoints, which allows the PLC to properly operate the system:

A. The PLC shall have two setpoints for zone field flushing operations:

- The OIC shall have provision for entering a setpoint for the "interval been field flushes". The setpoint shall be in days and shall range from 7 to 30. The default value shall be 14 days.
- The OIC shall have provision for entering a setpoint for the "field flush time". This time will be utilized by the PLC for field flushing each zone. The setpoint shall be in seconds and shall range from 20 to 600. The default value shall be 300 seconds.

B. The PLC shall have three setpoints for filter backwash operations:

- The OIC shall have provision for entering a setpoint for the "maximum time between backwashes". The setpoint shall be in minutes and shall range from 25 to 900. The default value shall be 120 minutes.
- The OIC shall have provision for entering a setpoint for the "filter backwash time". This time will be utilized by the PLC for backwashing of each filter. The setpoint shall be in seconds and shall range from 5 to 60. The default value shall be 10 seconds.

C. The OIC shall have provision for entering a setpoint for the "gallons per pulse" of the digital flow meter. This value will be used by the PLC to calculate flows and to determine alarm conditions. The input is in floating-point and may incorporate a decimal value. The setpoint shall be in gallons and shall range from 0.5 to 100 to reflect the meter output. The default value shall be 1 gallon per pulse.

PART 2 – FLOAT OPERATIONS

2.01 GENERAL

The level in the wetwell shall be detected by a five-float system. The system of floats shall perform both control and failure detection tasks. The five floats shall be:

A. Backup off and low wetwell level alarm float (LLA Float).
   - The LLA Float shall be tested by PLC logic for failing to close.

B. Off float (Off Float).
   - The Off Float shall be tested by PLC logic for failing to close.

C. Zones enable and pump run float (Run Float).
   - The Run Float shall be tested by PLC logic for failing to close and open.

D. High duty and backup enable float (HD Float).
   - The HD Float shall be tested by PLC logic for failing to open.

E. High wetwell level alarm float (HLA Float).
   - The HD Float shall be tested by PLC logic for failing to open.

2.02 FLOAT CONTROL LOGIC

The five-float system shall control the operation of the zones and shall perform several additional control functions. The float system shall be designed to continue to perform the control functions under single float failure conditions:

A. The Run Float shall latch a "zones enabled" bit in the PLC. The Off Float shall unlatch the "zones enable" bit. Once the "zones enabled" bit is latched on, the PLC shall open a zone valve (or two zone valves, depending on configuration) if the currently selected zone(s) are fully "rested".

B. If either the LLA Float or Off Float has failed "open", then the Run Float shall assume the operational duties of the Off Float in the PLC.

C. If the LLA Float, Off Float or Run Float has failed "open", then the HD Float shall assume the operational duties of the Run Float in the PLC.

D. The HD Float shall latch a "high duty" bit "on" in the PLC. The Run Float shall unlatch the "High Duty Call" bit. Once the "high duty" bit is latched on, the PLC shall increase by 50% the total gallons being dosed (assuming that the base system design requires zone dosing less than 25 percent of the time each day).

E. If the LLA Float, Off Float, Run Float, or HD Float has failed "open", then the HLA Float shall assume the operational duties of the HD Float in the PLC.

F. If the LLA Float drops (low wetwell level alarm) a backwash cycle shall be stopped by the PLC and restarted from the beginning after the Off Float rises.

2.03 FLOAT FAILURE AND ALARM LOGIC

The five-float system shall allow the testing of individual floats for failure conditions. The bottom three (LLA, Off, and Run) floats are tested for failure to close (failed open). The top three (HLA, HD, and Run) floats are tested for failure to open (failed closed). Two out of three failure detection logic shall be employed to determine if a float has failed to function properly.

A. When the LLA Float drops, a "low wetwell level" alarm bit shall be latched in the PLC. The OIC shall display the alarm and the PLC shall trigger the Autodialer to call out the alarm. The alarm bit shall be unlatched when the Off Float rises.

B. When the LLA Float fails, the "low wetwell level" alarm shall be disabled by the PLC.

C. When the HLA Float rises, a "high wetwell level" alarm bit shall be latched in the PLC. The OIC shall display the alarm and the PLC shall trigger the Autodialer to call out the alarm. The alarm bit shall be unlatched when the HD Float drops.
D. When the HLA Float fails, the "high wetwell level" Alarm shall be disabled by the PLC.
E. When an individual float fails, a failure bit shall be set in the PLC, the OIC shall display the failure and the PLC shall trigger the Autodialer to call out the alarm.
F. The OIC shall have a reset bit to unlatch the float failure bits and the wetwell level alarm bits.

2.04 WETWELL LEVEL DISPLAY
The OIC, based on the status of the floats and whether the level is rising or falling, shall display the operational wetwell level. The OIC shall also display operational data related to the float levels. The OIC shall display alarms for low and high wetwell level.

2.05 MANUAL TESTING AND INPUT OF FLOAT LOGIC
The Control Panel shall have HOA switches for each float input to force a float "up" input signal (HAND), to disable the float "up" input signal (OFF), and to allow automatic operation of the float input signal (AUTO). The HAND and OFF positions shall allow testing and manual operation of the float system.

PART 3 – PUMP OPERATIONS

3.01 GENERAL
The dosing pumps shall include the following components:
A. The drip irrigation system shall operate with either one or two dosing pumps.
B. The OIC shall have a "software" HOA switch displayed. The OIC HOA shall control bits, which allow the PLC to control the output to each dosing pump starter through the AUTO path of the physical HOA switch.
C. The Control Panel shall have a hard-wired HOA switch to manually control the run signal command for each dosing pump's starter.
D. The Control Panel HOA switch shall activate the output signal (HAND), deactivate the output signal (OFF), and allow automatic operation of the PLC output signal (AUTO).
E. Each dosing pump shall provide a "starter closed" signal to the PLC to confirm that the pump is running.
F. The Control Panel shall have an HOA switch for each "pump running" input to force an input signal (HAND), to disable the input signal (OFF), and to allow automatic operation of the input signal (AUTO).
G. If the drip irrigation system has two dosing pumps, then the PLC shall have a "software" alternator to balance the dosing pumps run time.

3.02 PUMP OPERATION
The PLC shall control dosing pump operations based on the following criteria:
A. A dosing pump shall run in HAND (software HOA) unless in low Wetwell level alarm.
B. A dosing pump shall run during calls for backwash of filters if:

- It is in AUTO (software HOA),
- It is the lead pump (software alternator), and
- The wetwell is not in low-level alarm.

C. A dosing pump shall run during calls for zone field flush if:
- The pump philosophy bit is set (large pump mode)
- It is in AUTO (software HOA),
- It is the lead pump (software alternator), and
- The "zones enabled" bit from float logic is set.
- A zone is ready to be dosed.

D. A dosing pump shall run during calls for zone field flush if:
- The pump philosophy bit is not set (small pump mode)
- It is in AUTO (software HOA),
- The "zones enabled" bit from float logic is set.
- A zone is ready to be dosed.

E. A dosing pump shall run if:
- It is in AUTO (software HOA),
- The pump philosophy bit is not set (small pump mode)
- It is the lead pump (software alternator), and
- The "zones enabled" bit from float logic is set.
- A zone is ready to be dosed.

F. A dosing pump shall run if:
- It is in AUTO (software HOA),
- The pump philosophy bit is set (large pump mode)
- It is the lead pump (software alternator), and
- The "zones enabled" bit from float logic is set.
- Both selected zones are ready to be dosed.

3.03 PUMP ALARMS

The PLC shall test the operational status of dosing pumps to determine if a pump has failed. The failure test criteria shall be as follows:

A. A "failed to run" alarm bit shall be latched if a "pump running" signal is not received for 60 seconds when a command to run is generated by the PLC. The OIC shall display the failure and the PLC shall trigger the Autodialer to call out the alarm.

B. The "failure to run" shall be triggered by electrical problems detected in the pump motor, by power supply quality problems, and by the Control Panel dosing pump HOA being left in the OFF position.

C. A "failed to generate flow" alarm bit shall be latched if sufficient flow does not occur in the 120 seconds following the initiation of a command by the PLC for a dosing pump to run. The OIC shall display the failure and the PLC shall trigger the Autodialer to call out the alarm.

D. Once pump flow has been received, a "pump flow OK" bit shall be latched to require the PLC to consider only zone "no flow" conditions if flow stops (as long as the pump continues its current run). This "pump flow OK" bit will be unlatched when the pump stops.

E. The OIC shall have a reset for unlatching all dosing pump alarm bits. The "failure to run" bit shall also be reset if the PLC receives a "pump running" signal from the dosing pump starter.

3.04 PUMP MANUAL OPERATION AND TESTING

The Control Panel shall have HOA switches for each dosing pump to force the pump to run (HAND), to disable the pump (OFF), and to allow automatic operation by the PLC of the pump (AUTO). The HAND and OFF positions shall allow testing and manual operation of each dosing pump.

3.05 PUMP ELAPSED RUN TIME METERS

The PLC shall have software generated Elapsed Run Time Meters (ETM) which accumulate total run time for each dosing pump in minutes and hours. The OIC shall display the run times.

PART 4 – FILTER BACKWASH OPERATIONS

4.01 GENERAL

The filter system shall be designed with two to ten filters. Each filter will have a backwash valve to reverse the flow through the filter. The OIC shall have an input register to receive the configuration information on how many filters are utilized. Once this value is inputted, the OIC and PLC shall reconfigure the "backwash" screen and logic to display and operate that exact amount of filters.

4.02 CALL FOR BACKWASH

A backwash of filters shall be started by three circumstances:

A. If the pressure across the filters climbs above the manual setting on the pressure switch, the switch output will close and a timer shall be activated in the PLC. If the pressure switch stays closed for 15 seconds, the "call for backwash" bit shall be latched by the PLC.
B. The PLC shall accumulate current elapsed dosing time. If the elapsed dosing time since the last backwash exceeds the inputted setpoint, the "call for backwash" bit shall be latched by the PLC.
C. The OIC shall allow for manual call for backwash. Once the "manual backwash" bit is set on the OIC screen, the PLC shall latch the "call for backwash" bit.
D. The "call for backwash" bit, the "manual backwash" bit, and the "elapsed dosing time from last backwash" timer shall be reset when the last filter has been backwashed.
E. If the "low wetwell level" alarm is triggered, the backwash shall be stopped, all backwash timers shall be reset, but the "call for backwash" bit shall remain latched. When the OFF Float rises, the backwash shall be reinitiated.
F. The OIC shall allow for manual stopping for backwash. Once the "stop backwash" bit is set on the OIC screen, the PLC shall unlatch the "call for backwash" bit and reset all backwash timers and bits.

4.03 BACKWASH OPERATION LOGIC

Once the call for backwash bit has been set by the PLC, the below listed operational procedures shall be initiated by the PLC:

A. A filter backwash shall take precedence over zone dosing and field flushing.
B. A master valve shall (may) be shut to isolate flow to the filter being backwashed.
C. A delay timer shall run for ten seconds to allow the master valve time to close.
D. Each filter, in sequence, shall have its backwash valve opened for the inputted setpoint time.
E. The completion of each filter's backwash is followed by a short delay before the next filter starts its backwash.

4.04 OIC DISPLAY OF BACKWASH OPERATIONS

The OIC shall display the filters and which filter is being backwashed. The OIC shall display the elapsed dosing run time since last backwash (in minutes). The OIC shall display how the backwash was initiated. The OIC shall display the backwash setpoints.

PART 5 – ZONE DOSING OPERATIONS

5.01 GENERAL

The zone system shall be designed with six to thirty filters. Each zone will have a valve to allow flow into the irrigation piping for that zone. The OIC shall have an input register to receive the configuration information on how many zones are installed. Once this value is inputted, the OIC and PLC shall reconfigure the "zone 1-15" and "zone 16-30" screens and logic to display and operate that exact amount of zones. The OIC shall display a control screen for each installed zone.

5.02 ZONE HOA SWITCHES

A. The Control Panel shall have an installed HOA switch for the output to each zone dosing valve. The HAND circuit shall be used to manually force the zone dosing valve open. The OFF circuit shall be used to physically block operation of the zone dosing valve; however, the PLC will have no indication of this setting other than there will be no flow when the zone is selected for operation.
B. A "software" HOA switch for the output to each zone dosing valve shall be included in the PLC logic. The output of the PLC logic shall be wired through the AUTO of the hard-wired HOA switch. The OIC shall control the bits to the PLC "software HOA through a displayed HOA switch on each zone control screen.
C. If a zone has no flow and is considered to have failed, the PLC shall place the "software" HOA for the zone into OFF.
D. The PLC logic shall prevent a zone "software" HOA from being both in HAND and AUTO.

5.03 ZONE ELAPSED DOSING TIME METERS

The PLC shall have software generated Elapsed Dosing Time Meters (ETM), which accumulate total dosing time for each zone in minutes and hours. The OIC shall display the dosing times for each zone on the zone control screen.

5.04 ZONE TOTALIZED DOSING FLOW METERS

The PLC shall have software generated Totalized Dosing Flow Meters, which accumulate total gallons dosed to each zone in gallons and thousand gallons. The OIC shall display the dosing meters for each zone on the zone control screen.

5.05 ZONE CURRENT DOSING FLOW METERS

The PLC shall have software generated Current Dosing Flow Meters, which accumulate the gallons dosed to a zone during its current operation. This computation is initiated only when the dosing to a zone is being controlled by a flow (gallons) setpoint. The OIC shall display the current flow to a zone (only when in the flow setpoint mode) on the zone control screen.

5.06 ZONE DOSING RUN TIMES, REST TIMES, FLOW SETPOINTS

Each zone can have an individualized value placed its registers for the three setpoints below:

A. The dosing run time for each zone shall be entered and displayed on the zone control screen by the OIC. The required run time shall range from 0 to 30 minutes.
B. The dosing rest time for each zone shall be entered and displayed on the zone control screen by the OIC. The required rest time shall range from 0 to 300 minutes.
C. The dosing required gallons for each zone shall be entered and displayed on the zone control screen by the OIC when in that mode of operation. The dosing required gallons shall range from 10 to 1000 gallons.

5.07 ZONE DOSING OPERATIONS

The PLC shall control the dosing of the zones in automatic operation. Listed below are the conditions that must be met for a zone dosing valve to be opened:

A. The zone's rest timer is timed out.
B. The zone alternator in either small pump or large pump mode is selecting the zone. If the zone "software" HOA is not in AUTO, the alternator shall skip the zone.
C. The secondary selection in large pump mode is selecting the zone. If the zone "software" HOA is not in AUTO, the alternator shall skip the pair of zones.
D. The "zones enabled" bit is latched

Once the zone valve is opened the zone will be dosed when:

E. A pump is running for dosing purposes.
F. A pump is running for field flush purposes.
G. A pump is running for backwash purposes and the master valve is not closed.

The zone dosing valve shall be shut by the following conditions:

H. The "zones enabled" bit is unlatched during the zones current dosing run.
I. The PLC shall remember how much dosing time remains and shall restart the dosing on the current, partially dosed zone when the "zones enabled" bit is latched once more.
J. The OIC shall have a zone alternator advance button, which shall cause the PLC to jump the alternator to the next zone.
K. The current zone shall retain the current run settings for completion of the dosing run the next time the zone is selected.
L. The zone completes its dosing run.

After the zone has been dosed in AUTO mode or field flushed in AUTO mode, the PLC shall rest the zone for the required amount of time. If the system is in large pump mode where two zones must be dosed simultaneously, both selected zones shall have to be fully rested before the zone dosing will start.

PART 6 – ZONE FIELD FLUSHING OPERATIONS

A counter that counts days shall initiate the zone field flushing. The OIC shall have an input register to receive the configuration information on how many days are to pass between field flushes. Field flushes are identical to individual zone dosing with the exception that field flush flow shall be doubled the normal dosing flow. Field flushing shall be a set time per zone. Normal dosing shall resume once a zones have been field flushed.

END OF SECTION

SECTION 13XXX
CONTROL PANEL
(DICP Models 02-412NC, 412, 622, 826, 1030)

1.01 SCOPE

This section includes the furnishings of a Control Panel as described herein, as manufactured by TEI Controls, Austin Tx, (512) 259-2977. The panel is to control all dosing and filter backwashing operations.

1.02 ENCLOSURE

The Control Panel shall be housed in a padlockable fiberglass Nema 4X enclosure with stainless steel hardware and an aluminum backplate. The Control Panel shall have a door-mounted color graphic display touch screen interface for operator input. The enclosure and backplate listed below shall be as manufactured by Stahlin or an approved equal.

A. DICP Models 02-412: Enclosure N24208HWT and Backplate BP2420AL
B. DICP Models 02-622: Enclosure N30247HWT and Backplate BP3024AL
C. DICP Model 02-826/1030: Enclosure N36308HWT and Backplate BP3630AL

1.03 MOTOR CIRCUIT BREAKERS

The Control Panel shall contain two IEC rated Circuit Breakers, din rail mounted, with high inrush curve for motors. The Circuit Breaker shall be sized per the plans and specifications to protect the starters and shall be a 5SX2?-??-8 as manufactured by Siemens or an approved equal.

1.04 MOTOR STARTERS

The Control Panel shall contain two IEC rated starters. Starters will be wired for either single-phase or three-phase operation and sized per the plans and specifications. The starters shall be a Freedom type AE17 as manufactured by Cutler-Hammer or an approved equal. If the motors are single phase and require starting capacitors and relays, such capacitors and relays shall be mounted in a separate matching enclosure.

1.05 INTERFACE PANEL

The control panel will have a Nema 4 door-mounted color operator interface touch panel with a six inch, 16x12 screen display. Operator interface will support 128 colors and have a non-volatile flash memory card for user program backup. The operator interface will be linked to an internal programmable logic controller. From the interface panel, irrigation zones and pumps may be set for hand/off/auto operation and “rest” and “run” times may be programmed individually for each zone. The operator interface shall be an EZ-S6C-FS as manufactured by Automation Direct or an approved equal. If the Control Panel is installed outside, the OIC shall be din rail mounted on the inside of the enclosure door.

1.06 PROGRAMMABLE LOGIC CONTROLLER

The programmable logic controller shall be din rail mounted, non-volatile memory module for back-up, analog expandable, high-speed counter, real time clock, RS-232 port, andDH-485. The PLC and modules shall be manufactured by Allen-Bradley or an approved equal.

A. DICP Model 02-412NC: MicroLogix 1200 1762-L24AWA with a 1762-OB16 output module.
B. DICP Models:02-412/622/826/1030: MicroLogix Model 1500 comprised of a 1764-24AWA base unit with a 1764-LSP processor and a 1769-OB16 output module. If communications are required, a 1764-LRP processor with a 1764-RTC time clock will replace the 1764-LSP.

1.07 ISOLATION INPUT/OUTPUT RELAYS
Each individual input/output signal shall be isolated with a relay. Each I/O shall have a selector switch for manual operation and an indicating LED. The selector switch shall be a 3-position (hand-off-auto) switch. Output terminals to accept #10 wire. The isolation input/output shall be din rail mounted and be a 6-OI as manufactured by TEI Controls or an approved equal.

1.08 UNINTERRUPTIBLE POWER SUPPLY
If required by the plans and specifications, the Control Panel shall contain an Uninterruptible Power Supply model BCPERS300 as manufactured by Tripp Lite or an approved equal. UPS must fit inside the Control Panel.

1.09 CONTROL POWER TRANSFORMER
The Control Panel shall contain 100VA Primary to 24VAC Secondary control power transformer model 9070-TF100D3 as manufactured by Square D or an approved equal.

1.10 POWER SUPPLY
The Control Panel shall contain a din rail mounted 1.3 amp power supply, 120V to 24VDC, model 6EP1331-SH01 as manufactured by Siemens or an approved equal.

1.11 TERMINAL BLOCKS
The din rail mounted terminal blocks shall be a model DINector as manufactured by Automation Direct or an approved equal.

1.12 FUNCTIONS
See Section 13XXX Control Description

1.13 PROGRAMMING
The Control Panel supplier, or an approved equal shall do the programming of the PLC.

1.14 DOCUMENTS
Electrical schematics shall be provided for the Control Panel. The schematics shall be protected by plastic laminate.

1.15 ACCEPTABLE CONTROL PANEL MANUFACTURE
The Control Panel shall be manufactured by TEI Controls, PO Box 200122, Austin, Tx 78720-0122, (512) 259-2977, fax (512) 259-1979, www.teicontrols.com, or an approved equal.

END OF SECTION